

the trust-like company of the Loire was formed, that was the prototype of the coal trusts and syndicates of to-day. Events such as these had a far-reaching influence on the development of the coal-mining industry.

Special commendation is due to the author for the scrupulous accuracy with which references to original authorities are given, and for the care with which the proof-sheets have been read. Two trifling misprints have, however, escaped detection. Freiberg appears as "Freyburg" (p. 292), and Sir Marc Isambard Brunel as "M. J. Brunel" (p. 291).

BENNETT H. BROUGH.

MATHEMATICS OF BILLIARDS.

Billiards Mathematically Treated. By G. W. Hemming, K.C. Second edition. Pp. 61. (London: Macmillan and Co., Ltd., 1904.) Price 3s. 6d. net.

MORE fortunate, or more careful, than most authors, Mr. Hemming, whose recent death will be regretted by many, did not find it necessary in his second edition to make any material alterations in his original work. He added two appendices, iii. and iv., with which alone it is necessary to deal in the present notice.

Appendix iii. discusses the comparative advantages of fine and through strokes, with regard to the margin of error permissible in the respective cases. In the figure opposite p. 47, A is the player's ball, O the object ball, and the stroke is to make A, after striking O, pass within a distance of the point P depending on the nature of the stroke, namely, for a cannon a distance equal to the diameter of a ball, for a losing hazard the necessary distance from the centre of the pocket, which may vary between different tables. The angle AOP is given by the conditions of the problem, and in the notation adopted is $\pi - \Delta$. The angle of aim, OAS, is the thing to be determined. It shall be denoted by α , as in appendix ii. of the first edition. In the present appendix A_1 is also used for the same angle. S denotes the position of the centre of the striking ball at impact, SO being the common normal. If $ASO = \pi - \theta$, θ and α are connected by the relation $\sin \theta / \sin \alpha = AO / OS = AO / 2$ if we denote OS, the diameter of a ball, by 2; and in the special case considered of $AO = PO = 30$, or 15 diameters, we might to a very near approximation use α instead of $\sin \alpha$. Further, the angle OPS is denoted by P_1 , and the angle of deviation, $\pi - ASP$, by δ . It is then shown that as the equation connecting δ and θ ,

$$\tan(\theta + \delta) = p \tan \theta,$$

where, for reasons given in the former edition, $p = 3.5$. From this last equation δ may be obtained in terms of θ or α . In fact,

$$\tan \delta = (p - 1) \sin \theta \cos \theta / (\cos^2 \theta + p \sin^2 \theta)$$

is easily found.

The complete method, were it practicable, would be to find an equation in θ or α having two roots, one of which, say θ_1 , should correspond to the fine, the other, θ_2 , to the through, stroke, and thence the margin of error might be found for each stroke. This analysis being difficult, a practical solution is obtained by means

of a diagram in which the ordinate y represents $\sin \Delta$, given by the conditions, and the abscissa x represents $\sin \theta$ in an actual stroke in which, for given Δ , the ball A passes over or very near to P. A series of values of $\sin \theta$ being found corresponding to a series of values of $\sin \Delta$, we draw a freehand curve through them. In general, a line parallel to x for given y cuts this curve in two points, namely, P_y , in which θ has the smaller value (the through stroke), and Q_y , in which it has the greater value (the fine stroke). It comes next in order to find for any y the margin of error for P_y and for Q_y . This is done by using the formula of appendix ii., first edition. The linear error on the object ball is (AO being 30) $30\delta\alpha$. The consequent linear error at P (PO = 30) is denoted by E. Then $30\delta\alpha/E$ gives the margin of error. A new curve, called the blue curve, is then drawn, having for abscissa $x = \sin \theta$, and for ordinate $y = 30\delta\alpha/E$, in the same way, by a series of trials, as the first curve. The blue curve has two branches. Then the margin of error for any of the points P_y or Q_y of the first curve is that ordinate of the blue curve which has the same abscissa. As the result of this method it is found that the margin of error is the same for the through as for the fine stroke, when $\sin \Delta = 0.320$, and $\sin \theta = 0.132$ for the through, and $\sin \theta = 0.960$ for the fine stroke. For smaller values of Δ the through stroke has the advantage; for larger values of Δ the fine stroke, until a certain maximum is reached.

In appendix iv., f , the coefficient of friction between two balls at impact, formerly taken as zero, is assumed to have the values 0.01 or 0.02, and it is found that, instead of $p = 3.5$, as above assumed, we should have

$$\begin{aligned} \text{for } f = 0.01 \quad p' &= 3.445 + 0.0625 \cos \theta \\ \text{for } f = 0.02 \quad p' &= 3.391 + 0.125 \cos \theta. \end{aligned}$$

It will be observed that both these values of p' give very approximately $p' = 3.5$ when $\theta = 30^\circ$, that is, for the half-ball stroke.

Before this notice was in type Mr. Hemming was taken from us by death, to the sincere regret of his many friends, including the present writer.

S. H. BURBURY.

A MORPHOLOGY OF THE ALGÆ.

Morphologie und Biologie der Algen. By Dr. Friedrich Oltmanns. Vol. i. Special part. Pp. vi + 733; illustrated. (Jena: Gustav Fischer, 1904.)

THE charming little university town of Freiburg has been the birthplace of important ideas in an obscure department of natural history. De Bary began there his researches into the life-history of the lower fungi, and afterwards continued them at Halle and Strassburg. Owing to his great work and inspiration we botanists owe a germ-theory of disease—a theory which was in time to bear fruit in practical, medical and surgical form in the mighty hands of Lord Lister. To Freiburg, then, we come again for a morphology of the kindred group of the Algæ.

There is a difficulty in understanding how even an assiduous German professor, living so remote from the sea as Freiburg is, can have obtained the inspiration which has guided his research for years past. The

study of organisms, which in a living state are for the most part many hundreds of miles from his door, must have presented a task in conquering which his zeal and power of work can find no better example than the volume before us. To a great extent this work must have been book work, and excellent book work it is, the purely bibliographical work especially; and with the aid of herbarium specimens Dr. Oltmanns has succeeded in giving us a general morphology of the Algæ—a treatise to have been expected only from one with abundant leisure and a microscope near the sea. To approach, then, in a spirit of criticism an encyclopædic book of this kind, to try to gauge its worth, seems in the circumstances scarcely “sportsmanlike,” if I may use such a term, on the part of one who has had so many greater opportunities of observation.

The De Bary of the subject is, of course, Dr. Bornet, and no student can for a moment question his pre-eminent claims to instruct us. Schmitz, of Greifswald, whose loss we can never cease to deplore, seemed destined to employ his indomitable industry in a work of this kind. Happily we have Dr. Oltmanns, and happily he has had the courage to undertake a task so full of use and pleasure to all students of this fascinating group of plants.

I do not wish for a moment even to seem to detract from the great performance of Dr. Oltmanns. One irresistibly comes back to the Freiburg and De Bary standard. One hoped for a general morphology of the Algæ as De Bary gave us one of the fungi. Dr. Oltmanns has given us an encyclopædic book—an admirable one—but not the reasoned work of genius botanists have dreamt of.

According to personal prejudice, very possibly, I mean prejudice in the right sense of the word, I turned first to the obscure groups of primitive Algæ, groups that I have had so many opportunities of studying on the sea, and of which Dr. Oltmanns can have had few chances of seeing living specimens. It so happened that while writing this review the present writer was engaged in describing a new generic form of pelagic Alga obtained on the outward voyage of the *Discovery*. The point was put to the test by consulting Dr. Oltmanns's descriptions and bibliography. From that, of course, the original sources were taken and verified, not so much for the immediate purpose, as was natural in any case, as for the aim of doing justice in reviewing Dr. Oltmanns's book. The result was triumphant for Dr. Oltmanns—every reference and every description having been pursued to its original source. It is difficult to establish a negative, but no reference was found wanting.

Naturally one turned next to the group Dr. Oltmanns has made his own—the Fucaceæ. It may seem presumption, but it was dutiful, and here, again, the book stood every test. The other groups of Algæ were not made the subject of such rigorous treatment, but they were examined with scrutiny enough to warrant the expression of a very warm and hearty recommendation of this great book to the consideration of botanists and cultivated readers.

GEORGE MURRAY.

OUR BOOK SHELF.

Game, Shore and Water Birds of India: with Additional References to their Allied Species in Other Parts of the World. By Colonel A. Le Messurier, C.I.E., F.Z.S., F.G.S. Fourth edition. Pp. xvi+323. (London: Thacker and Co., 1904.)

THE first edition of this work was a modest little volume, printed for private circulation only, on the birds of Sind. This appeared so far back as 1874. Four years later, with some additions, it was issued to the public. Hume and Marshall's epoch-making work on the game birds of India appearing at the same time made a third edition imperative. This in due time appeared, and large additions were made thereto, taken, with acknowledgments, from this formidable rival. Meeting with a well merited success, a fourth edition has now been issued, which differs from the earlier volumes in that it “includes references to all species in other parts of the world that are allied to the Game, Shore, and Water Birds of India.”

This addition is made on the curious plea that “owing to the facilities of travel, Anglo-Indians are now engaged in most countries either on business or pleasure.” It is to be supposed that Anglo-Indian sportsmen are here specially referred to, and further, that, save for this volume, no information concerning the avifauna of the countries they propose to visit is obtainable. That this is not the case it is needless to say, and the traveller-sportsman would be ill advised who started on his journey with this volume for his only guide and counsellor.

In so far as it concerns the birds of India likely to interest the sportsman, this book will do very well; but it would have been vastly improved if the space now devoted to extra-Indian birds had been utilised for fuller descriptions of the native species, and for the description of the geographical and climatic conditions of the several regions of this vast hunting ground.

The introduction to this book contains, we venture to think, not a little that is out of place in a work of this kind. Much of it is admittedly compiled from abstruse scientific treatises, or from the labels of the Natural History Museum at South Kensington.

There can be no doubt but that the author, during his long residence in India and his wide experience in the field, must have accumulated a vast store of facts concerning Indian birds which would be well worth recording. For this reason, therefore, we regret that he decided on including in this edition matter really foreign to the scope of his book. His first-hand observations would have been of infinitely more interest and value than the compilation now presented.

The illustrations are numerous, and mostly very crude.

W. P. P.

The Species of Dalbergia of South-Eastern Asia. By Dr. D. Prain. (Annals of the Royal Botanic Gardens, Calcutta, vol. x., part i.) Pp. iv+114; and plates. (Calcutta, 1904.) Price 1l. 13s.

THE stages in the evolution of the genus *Dalbergia* are sketched in the early pages of this memoir. After removal of the extraneous species, the genus was delimited by Bentham in 1851, and four subdivisions, *Selenolobium*, *Dalbergaria*, *Sissoa*, and *Triptolomea*, were mapped out. Although Bentham himself pointed out that there was overlapping in these subdivisions, the grouping has been maintained by later systematists down to and including Taubert, who undertook the Leguminosæ for the “Pflanzenfamilien” in 1894. Dr. Prain, who had previously reviewed the genus when collating the Leguminosæ in connection with “Materials for a Flora of the